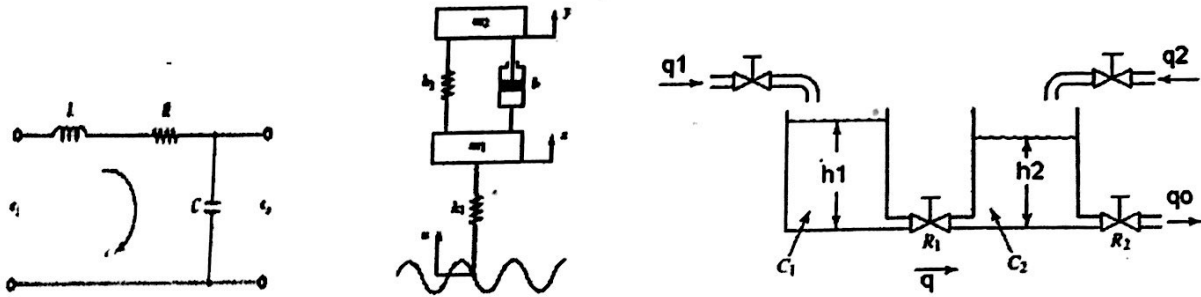


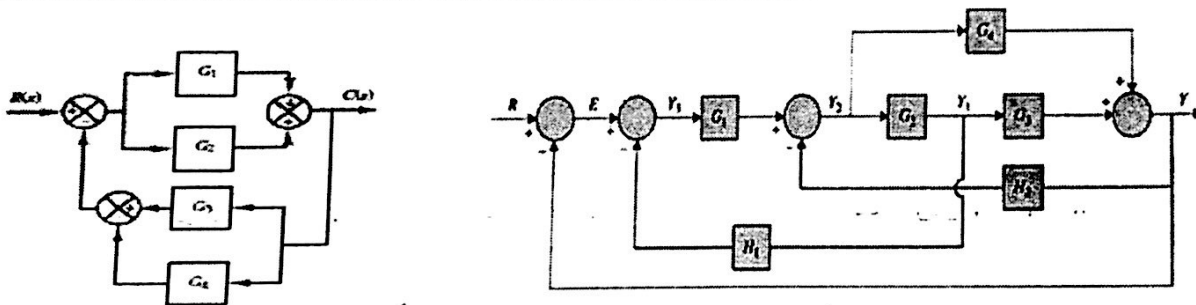
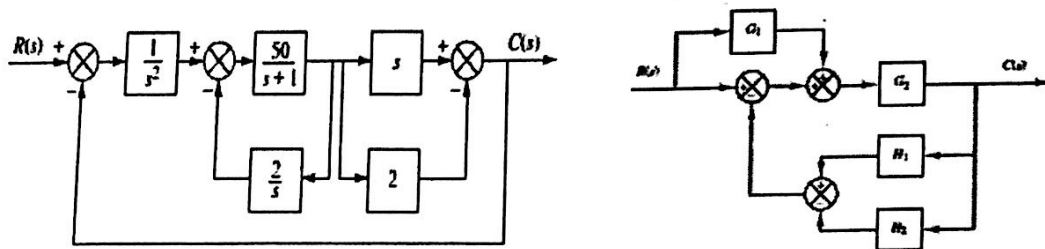
11. What is meaning by mathematical model?

12. What are the necessary information for model any physical system ?

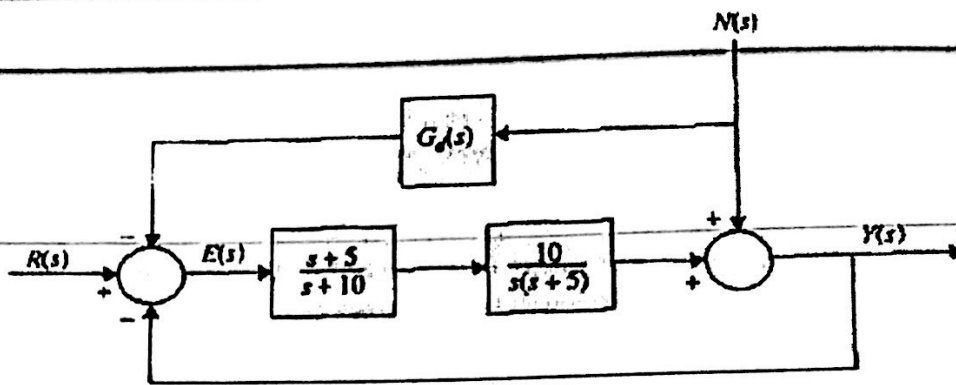
13. Find the mathematical model for:



14. Find the overall transfer function $C(s)/R(s)$ using block diagram reduction?

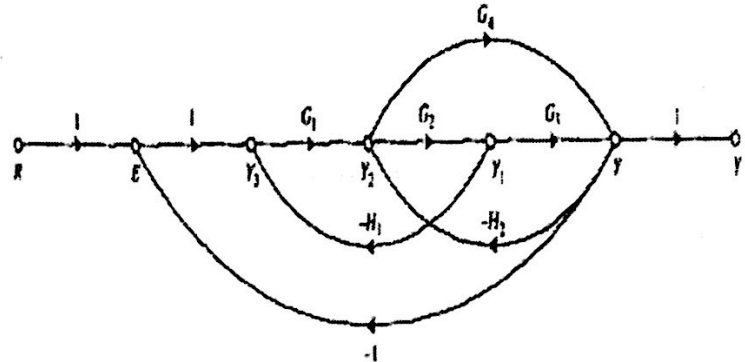
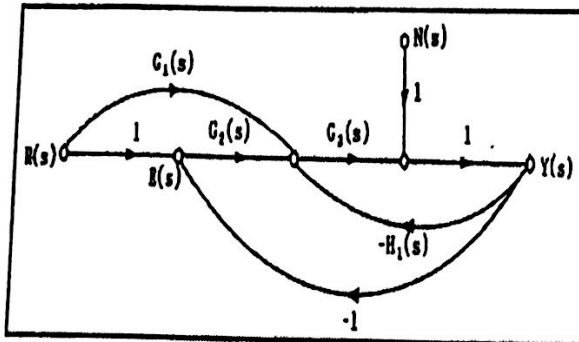


15. Find the transfer function $Y(s)/N(s)$, and determine the expression for $G_d(s)$ so that the effects of $N(s)$ can be eliminated.



16. Define the elements of Mason gain formula

17. Find the overall transfer function $C(s)/R(s)$ using Signal flow graph?



18. Find the state-space model for

$$\frac{Y(s)}{U(s)} = \frac{2s^2 + s + 5}{s^3 + 6s^2 + 11s + 4}$$

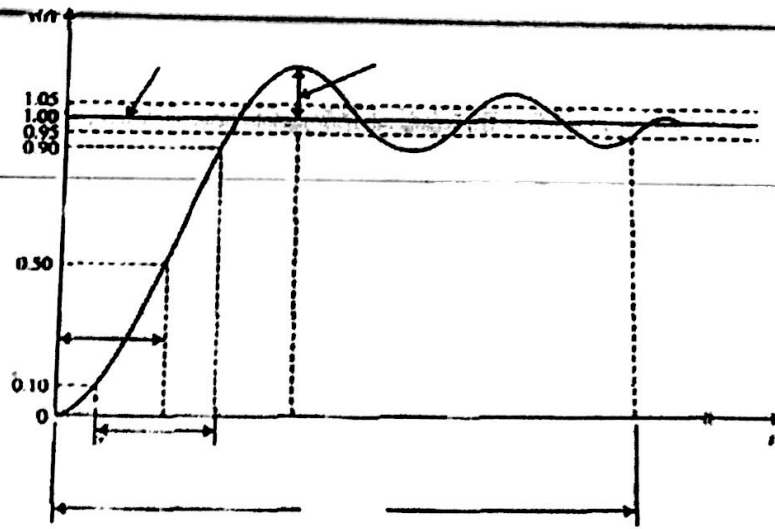
$$\frac{Y(s)}{U(s)} = \frac{1}{LCs^2 + RCs + 1}$$

Part 4 system analysis :

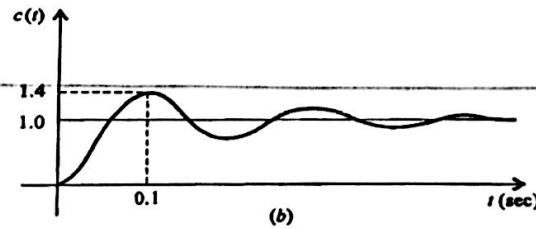
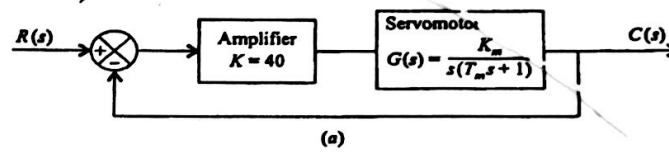
• Time domain analysis:

19. Draw the first and second-order responses as function of damping ratio. Show the poles locations.

20. Define the time domain specifications on the following figure



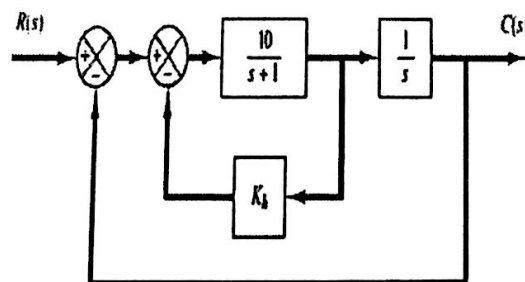
21. Find the value of K_m and T_m



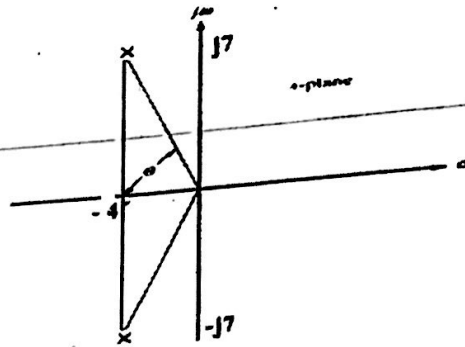
22. For a given transfer function below, find ζ and ω_n , overshoot M_p and T_s (setting time).....

$$\frac{C(s)}{R(s)} = \frac{36}{s^2 + 4.2s + 36}$$

23. Determine the value of k_h so that the damping ratio (ζ) = 0.5



24. Find the transfer function for



• **Part 4 (Steady-state error)**

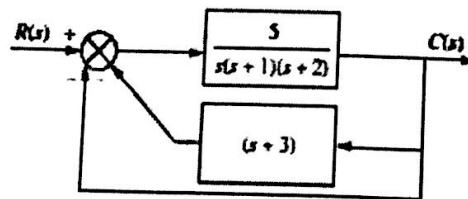
25. Name the test inputs used to evaluate steady-state error.
26. What is the relationship between the system type, input signal and steady state error.
27. If a unity negative feedback control system has the following closed loop transfer function

$$\frac{C(s)}{R(s)} = \frac{Ks + b}{s^2 + as + b}$$

Determine the open-loop transfer function $G(s)$ and then find the steady-state error.

28. The forward transfer function of a control system has three poles at 1, 2, 3. What is the system type?

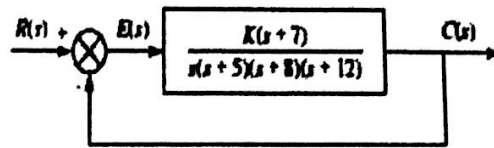
29. For the system shown in the following figure



- Find K_p , K_v , and K_a .
- Find the steady-state error for an input of $50u(t)$, $50tu(t)$, and $50t^2$.
- State the system type

30. For the system shown below;

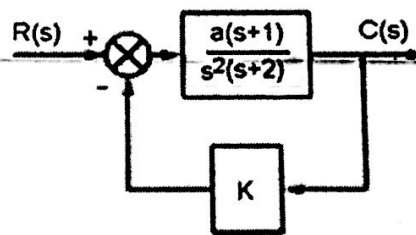
- (a) what value of k will yield a steady-state error in position of 0.01 for an input of $(1/10)t$?
 (b) what is the K_v for the value of k found in part a ?



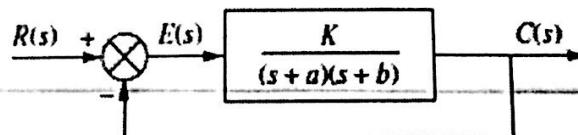
31. For the following system represented by the state-space method, find the steady-state error for both step and ramp input

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} -5 & -4 & -2 \\ -3 & -10 & 0 \\ -1 & 1 & -5 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 1 \\ 1 \\ 0 \end{bmatrix} u, \quad y = \begin{bmatrix} -1 & 2 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

32. Find the sensitivity of steady-state error to change to k and a .



33. Find the sensitivity of steady-state error to change to k and b .



• Part 4 (stability)

34. What is meaning by stability concept?
 35. Where do system poles have to be to ensure that a system is not unstable?
 36. What does the Routh-Hurwitz criterion tell us ?

37. If a seventh-order system has a row of zero at the s^3 row and two sign changes below the s^4 row, how many $j\omega$ poles does the system have?

38. Tell how many roots of the following polynomial are in the right-half-plane, in the left-plane, and on the $j\omega$ axis

$$P(s) = s^5 + 6s^3 + 5s^2 + 8s + 20$$

39. Use the Routh table, tell how many roots of the following polynomial are in the right-half-plane, in the left-plane, and on the $j\omega$ axis

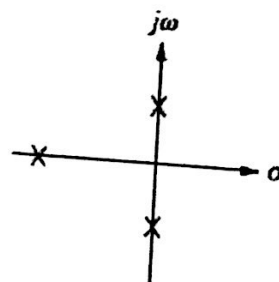
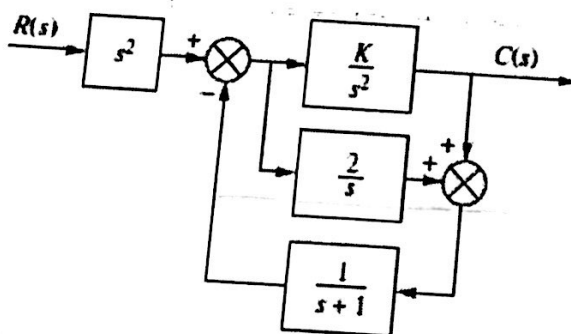
$$T(s) = \frac{s + 8}{s^5 - s^4 + 4s^3 - 4s^2 + 3s - 2}$$

40. Determine the characteristic equation for the following unity negative feedback system defined by its open loop transfer function given below and then

$$G(s) = \frac{K}{(s + 49)(s^2 + 4s + 5)}$$

- Find the range of K for stability.
- Find the value of K for marginal stability.
- Find the actual location of the closed-loop poles when the system is marginally stable.

41. Find the value of k in the system given below that will place the closed loop poles as shown



42. For the following system represented by state-space, find out how many roots of the following polynomial are in the right-half-plane, in the left-plane, and on the $j\omega$ axis

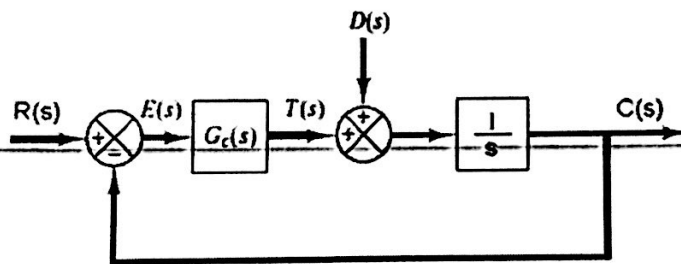
$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} -5 & -4 & -2 \\ -3 & -10 & 0 \\ -1 & 1 & -5 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 1 \\ 1 \\ 0 \end{bmatrix} u, \quad y = \begin{bmatrix} -1 & 2 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

Part 5 system design

43. What is the PD controller. Write its input-output transfer function, and Give its effects on the rise time and setting time of a control system.
44. What is the PI controller. Write its input-output transfer function, and Give its effects on the rise time and setting time of a control system.
45. What is the PID controller. Write its input-output transfer function.
46. Design a PD controller for the following negative-unity feedback system so that
- (1) Damping ratio $\zeta = 0.7$ (2) Undamped natural frequency (ω_n) = 10 rad/sec

Where $G(s) = \frac{10}{s(s+5)}$

47. Design a control $G_c(s)$ so that the effects of disturbance ($D(s)$) will be neglected



Good luck

Dr M M Bakush